

Revisiting the role of LCA and SLCA in the transition towards sustainable production and consumption

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Abstract

Purpose Life Cycle Analysis (LCA) and Social Life Cycle Analysis (SLCA) are tools acknowledged to have a role to play in the transition towards Sustainable Production and Consumption patterns (SPC). However, the role they play in this transition is seldom discussed, especially for SLCA. In addition, although the importance of taking a life cycle thinking (LCT) in the progression towards SPC seems indisputable, its added value is seldom made explicit. This article wishes to highlight the role of SLCA in the transition towards more sustainable production and consumption patterns and questions the relevance of LCT in this role.

Methods To answer this question, we first identify the applications of SLCA that correspond to actions that have to be taken in the transition towards SPC based on the SPC and SLCA literature. Then, the relevance of LCT in the context of the different applications identified previously is questioned through a qualitative discursive analysis approach.

Results The social goal of SPC is poorly discussed, and the SLCA literature can be one source of inspiration to define what this goal could be. On the basis of the UNEP-SETAC (2009) Guidelines' SLCA ultimate goal, SPC could be a means to improve stakeholders' social conditions through the improvement of enterprises' behaviours. The intended applications of SLCA for potentially supporting the improvement of enterprises' behaviours are found to be the identification of hotspots in order to highlight areas of improvement inside the sphere of influence of the SLCA user and the guidance of purchasing and substitution choices on the basis of enterprises' behaviours. In this article, it is suggested that, for SLCA to deserve the "LCT label", it has to capture impact transfers along the products' life cycle. Otherwise, an "ability-to-act-on" perspective is the proper angle to adopt in the identification of areas of improvement inside the sphere of influence and a "cradle-to-retailer", the one to adopt when SLCA is used to guide buy/boycott.

Conclusions Aside from revisiting the role of LCA and SLCA in SPC and the raison d'être of LCT, we discuss some considerations which we believe should be taken into account when developing SLCA in the context of SPC. In conclusion, this article points to the importance of framing the use of Life Cycle Sustainability Assessment tools in their context of use.

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1 Introduction

Life Cycle Analysis (LCA), Life Cycle Costing (LCC) and Social Life Cycle Analysis (SLCA) are analytical

tools¹ acknowledged to have a role to play in the transition towards Sustainable Production and Consumption patterns (SPC; UNEP-SETAC 2009²; UNEP 2011a³). LCA informs on the environmental impacts of products over their life cycle (ISO 14040 and 14044: 2006), LCC informs on cost encountered by different actors over the life cycle of products (Swarr et al. 2011) and SLCA informs on social performances of entities involved in the activities engaged in products' life cycle (UNEP-SETAC 2009).⁴ It is stated that, when used together, these tools can provide “more relevant results in the context of sustainability” (UNEP 2011a) and that, consequently, a Life Cycle Sustainability Assessment (LCSA) should involve the union of LCA, LCC and SLCA as suggested by the following conceptual formula: $LCSA = LCA \cup LCC \cup SLCA$ (UNEP 2011a⁵). The “context of sustainability” in which the results of LCSA are to be relevant is, however, not explicitly exposed. It has been suggested that the combined use of the LCSA tools would determine “to what extent a product is more sustainable than another” (Jorgensen et al. 2010). However, identifying what product is better than another supports one among many decisions that can benefit from LCSA tools. Indeed, the intended applications of LCA, LCC and SLCA include more than just a comparison between products. Accordingly, it seems important to highlight the different contexts in which LCSA tools are used to ensure that their scope of application is taken into consideration in their development. This is especially true for SLCA that is currently under construction.

In addition, the importance of taking a life cycle perspective for moving towards SPC seems indisputable. The importance of taking a life cycle perspective is emphasized in

the Ten Year Framework of Programs on SPC⁶ (10-YFP; UNDESA and UNEP, 2010), in the European Integrated Product Policy (CEC 2001, 2003), and, of course, in the LCSA tools literature (e.g. UNEP 2011a; UNEP-SETAC 2009; Klöpffer 2003). Since the focus on product in a life cycle perspective is the unique feature of the life cycle tools (Finnveden et al. 2009),⁷ it seems important to clarify the added value of a life cycle perspective (also referred as Life Cycle Thinking—LCT) in the SPC.

This article wishes to highlight the role of SLCA in the transition towards more sustainable production and consumption patterns (P&C) and question the relevance of LCT in this role. In other words, this article strives to answer “how does LCT, as a characteristic of SLCA, help the decisions and actions taken in the course of modifying P&C patterns to achieve more effectively the SPC objectives?” To answer this question, we first identify the applications of SLCA that correspond to actions that have to be taken in the transition towards SPC based on the SPC and SLCA literature (Section 2). The theoretical and idealistic pathway through which SLCA applications can lead to SPC will be made explicit.⁸ Then, the relevance of LCT in the context of the different applications identified previously is questioned through a qualitative discursive analysis approach (Section 3). The last section highlights some considerations that should be taken into account in the further development of SLCA if the tool is to be used in the context of SPC.

The main goal of this paper is to nourish the development of SLCA. However, the reflection of the different roles of LCA in SPC and the relevance of LCT in these roles are also highlighted; first, to guide our reflection on a very close but more-known field, and also because both the role of LCA in SPC and the relevance of LCT are seldom made explicit.

2 Applications of LCA and SLCA in the context of SPC

Since the Earth Summit of Rio in 1992, moving away from unsustainable P&C is recognized as an important means for

¹ Wrisberg et al. (2002) define analytical tools like “tools modeling the system in a quantitative or qualitative way aiming at providing technical information for a better decision.” They categorized LCA and LCC as such tools.

² In the SLCA guidelines (UNEP 2009), it is stated that “sustainable consumption and production [...] are the goals of LCA-based decision-making”.

³ In the LCSA guidelines (UNEP 2011a), it is stated that “LCSA can play a crucial role in this process », *this process* being « to achieve the aim of a Green Economy with sustainable consumption and production patterns”.

⁴ UNEP (2009) states that SLCA aims “to assess the social and socio-economic aspects of *products* and their *potential positive and negative impacts* along their life cycle” (italic from the authors). In a previous article (Parent et al. 2010), we argue that SLCA is assessing “social performances” rather than “social impacts” and that, in line with others (e.g. Macombe et al. 2010; Dreyer et al. 2006; Spillemaeckers et al. 2004), it is not the technical processes that are the main sources of stressors affecting stakeholders' social conditions but the organizations involved in the life cycle of a product.

⁵ Themselves adapting the formula from Klöpffer (2008) and Finkbeiner et al. (2010).

⁶ The 10-YFP is a framework offering a common structure—based on a LCT—to the different strategies, tools and programs required for the transition towards SPC. It is headed by the Process of Marrakech, a multi-stakeholders process supporting national and regional programs of SPC.

⁷ To be more precise, Finnveden et al. (2009) stated that “the unique feature of LCA is the focus on products in a life-cycle perspective”. But we feel plenty comfortable to extend this argument to the other LCSA tools.

⁸ A very similar exercise has been undertaken by Jorgensen et al. (2012). These authors analyze effects of different possible types of SLCA, when we analyze effects of SPC actions that can be supported by SLCA. The main similarities and differences between the two analyses are highlighted throughout the article.

the transition towards a sustainable development. The importance of SPC has been reconfirmed in 2002 with the Johannesburg Plan of implementation identifying SPC as a condition and an objective of a sustainable development (UN 2002). For a transition towards more SPC, actions have to be taken to change the course of actual P&C patterns. Therefore, if LCA and SLCA can provide information to support strategic planning or to position a product in the market, based on its already good environmental and social performances, we are interested here in applications that involve *changes in practices*, i.e. involve modifications of P&C patterns in line with the objectives of SPC. The premise here is that current P&C patterns are not sustainable, which is supported by the fact that international efforts are still mobilized to achieve SPC—e.g. the aforementioned 10-YFP.

Depending on the conceptualization one has of SPC, the objectives to fulfill can vary from eco-efficiency to sufficiency (Charkiewicz 2001; Fuchs and Lorek 2005; Alcott 2008). It is however broadly recognized that, for now at least, the objective of eco-efficiency is the one pursued (Fuchs and Lorek 2005). The agreed UN definition of SPC is, moreover, very similar to the definition by the World Business Council for Sustainable Development, both based on the continued need for eco-efficiency. Respectively, these definitions are: “the use of services and related products which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life-cycle so as not to jeopardize the needs of future generations” (Ministry of Norway 1994); and “the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth’s estimated carrying capacity” (this definition has been adopted in 1993; WBCSD 2000).

2.1 Environmentally sustainable P&C

Based on these definitions, the environmental objective of SPC is clear: reducing uptakes from the environment and emissions to the environment (the elementary flows) at the level of the product.⁹ This means that environmental impacts have to be lowered while fulfilling the function or service provided by products. This can be achieved through substitution of materials or energy sources, dematerialization of a product or a service, technical optimization of manufacturing processes, distribution chain optimization and other strategies related to design for the environment—also referred to as eco-design (Hauschild et al. 2005).

⁹ Products imply any of: goods, services and processes.

Theoretically and *ceteris paribus*, those physical interventions targeting the product would reduce the production level of unnecessary processes (i.e. processes producing inputs that are substituted or avoided through dematerialization) and increase the production level of substituting processes in the economy (the environmental goal is shown in bold in Fig. 1). Then, from an environmental point of view, intervening at the product level in order to green products (or product systems, meaning the different products required to fulfill a service) would result in a reduction of environmental impacts at the macro level through changing production levels; it greens the economy, for the same quantity of products produced and consumed. Changes in production level could also create a market incentive for producers to turn towards the production of substituting inputs, reinforcing the greening of the economy.

A broad variety of factors can influence producers to make interventions at the product level (see Maxwell and Sheate 2006). The European Integrated Product Policy emphasizes the need for “working with the market” (CEC 2003) and highlights eco-labeling and the internalization of the environmental costs into the prices of products as means to “strongly influence the life cycle environmental impacts of products” (CEC 2001). The latter would create a market incentive for physical interventions at the product level by raising the demand for greener products through a price incentive. Regarding the former, the demand for greener products would be enhanced through other means than a price incentive (e.g. through education, consciousness, peer pressure and factors modifying consumers’ values and priorities), and the eco-label would guide consumers towards the purchase of greener products. Whether it is through price incentives or not, this action requires that the appropriate signal is sent to the market in order to encourage interventions that will reduce environmental impacts for a given function; whether the environmental impacts are monetized or the environmental impacts are presented to the consumers so they can choose products with lower impacts. In both

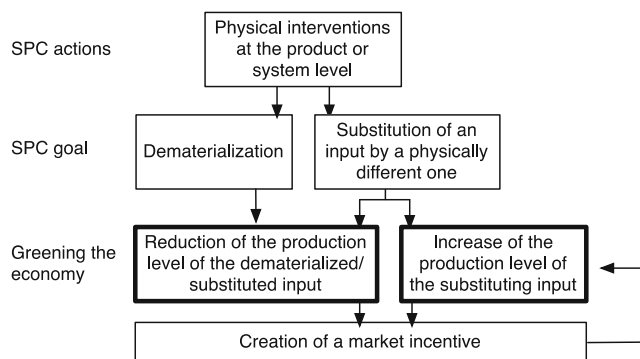


Fig. 1 Theoretical pathways between SCP actions, the SPC environmental goal and a greener economy

cases, the environmental impacts have to be identified (the further step of monetization will not be discussed here).

Therefore, for the environmental goal of SPC to be achieved using market forces, two main actions are required: physical interventions at the product or system level and the identification of adequate information to provide to consumers such that their purchases promote those physical interventions (eco-design). Strong legal regulations can also determine eco-design processes, but here we focus solely on the market pull incentive to eco-design.

According to ISO 14040 (2006), one application of LCA is the “integration of environmental aspects into product design and development (design for environment)”. LCA can support eco-design in identifying areas of intervention prior to the eco-design process (“identification of significant environmental aspects of the products and services of an organization” in ISO 2006) and in comparing design options (i.e. materials, technologies, process location; Rebitzer et al. 2004). Some ISO (2006) LCA applications also referred to the action of informing consumers: “Environmental labels and declarations”, “environmental communication” and more generally to marketing.¹⁰ Looking more closely at the role of LCA in these applications, LCA can either identify the criteria that should not be omitted when providing information (i.e. using LCA to identify life cycle steps and environmental impacts that should be documented for a product category—ISO 14024:1999) or provide the environmental profile of a product over its life cycle (ISO 14025:2006). In both cases, LCA supports the provision of information to consumers so they do not omit impacts.¹¹ The relevance of LCT to support these different applications in the goal of achieving a reduction of the environmental impacts of products is discussed in Section 3.

2.2 Socially sustainable P&C

The social dimension of sustainable development is seldom discussed in the context of SPC. One goal is highlighted in the UN SPC definition: providing “services and related products which respond to basic needs and bring a better quality of life”. At this stage of its development, SLCA still

poorly assesses the social impacts of products on people or societies consuming them and, therefore, does not provide information supporting this goal.¹² However, other social goals could be associated to SPC such as the “improvement of social conditions throughout the life cycle of a product” as promoted by the SLCA guidelines (UNEP-SETAC 2009). According to these guidelines, these social conditions can be affected by enterprises’ behaviours, socioeconomic processes and impacts on social capital. Knowing that SLCA is partly rooted in the field of Corporate Social Responsibility (CSR) and that it is broadly recognized in the SLCA literature that social conditions are mainly affected by enterprises’ behaviours (Macombe et al. 2010; Dreyer et al. 2006; Spillemaeckers et al. 2004), we focus here on that specific source of stressors. Therefore, for the present exercise, one social goal of SPC is to improve stakeholders’ social conditions through the improvement of enterprises’ behaviours.

The field of CSR offers different policy frameworks (e.g. UN Global Compact¹³) or guidelines for sustainability reporting (e.g. Global Reporting Initiative—GRI¹⁴) since it provides guiding principles for enterprises.¹⁵ SLCA methods making use of Performance reference points (PRP) assess whether or not an enterprise complies with those principles (or social norms) and to which extent they do it (see Parent et al. 2010, and UNEP-SETAC 2009, for details on the SLCA methods using PRP).¹⁶ Therefore, in the framework of SLCA using PRP (referred later as SLCA-PRP), if organizations are to improve stakeholders’ social conditions, a first course of action is to behave according to this set of prescribed principles. Where physical intervention at the product level is the ultimate action to promote the environmental goals of SPC, changing enterprises’ behaviour so that they are in line with acknowledged social norms is the ultimate action to achieve this social goal of SPC.

According to SLCA guidelines (UNEP-SETAC 2009), actions potentially supported by this tool are the same as for LCA: i.e. “learning about and identifying social

¹⁰ ISO 14040 (2006) also referred to “inclusion of environmental aspects in product standards” and “quantification, monitoring and reporting of entity and project emissions and removals, and validation, verification and certification of greenhouse gas emissions”, which are not discussed in this article. In addition, other applications are also often encountered in the LCA literature like strategic planning and policy making. Those actions would however need to be further defined to determine how they support SPC.

¹¹ This is true for environmental impacts covered in LCA. Indeed, as LCA does not assess all possible environmental impacts neither it considers effects induced outside the product life cycle system (in its attributional form), a purchase or a physical intervention based on LCA will omit impacts falling outside the scope of the tool.

¹² Which is however pointed as a subject that needed further researches (UNEP 2009; UNEP 2011a).

¹³ <http://www.unglobalcompact.org>

¹⁴ www.globalreporting.org

¹⁵ The GRI does not provide guidance on how to behave but, in prescribing subjects to report upon, suggests areas of concern enterprises are considered liable for, so they should act as society expects them to.

¹⁶ It is important to point here that the compliance of enterprises’ behaviours to social norms as a means to improve stakeholders’ social condition is criticized (e.g. Jorgensen et al. 2012 and Clift et al. 2012). Clift et al. (*ibid.*) use the example of the compliance to the ‘child labour free’ norm which can lead to a worse situation if the available alternative is prostitution. For the purpose of reflecting on the role of LCT in SLCA as a tool to support SPC, we, however, hold to the SLCA-PRP’s implicit assumption that compliance leads to enhancement of stakeholders’ social conditions.

“hotspots” and the options for reducing the potential negative impacts and risks through product development and substitution in the supply chain, establishment of purchasing procedures or specifications, marketing, reporting and labeling, strategic planning, or development of public policies” (*ibid*).

First of all, “learning about and identifying social hotspots” (*ibid*) are the direct results of SLCA which will support further actions and do not modify P&C patterns as such. It also appears relevant here to specify that a social hotspot is defined in the guidelines as an activity “located in a region where a situation occurs that may be considered as a problem, a risk or an opportunity, in relation to a social theme of interest.” For the sake of consistency in the use of concepts in LCA and SLCA, we suggest to use a definition closer to the one in LCA where hotspots are “elements within the system that contribute most to a certain impact category” (Thomassen et al. 2008a, b); social hotspots are therefore defined as areas where an improvement is required to achieve the social goal of SPC, which is understood here as the enhancement of enterprises’ behaviours.¹⁷

Concerning the reduction of “the potential negative impacts and risks through product development” (*ibid*), it seems to refer to the physical interventions at the product level. However, we argue that there is generally no need to physically modify a product when the goal is to modify enterprises’ behaviours. There are, of course, some social impacts that can be induced by specific production processes. It is the case of some health and safety issues. However, as the indicators used in SLCA-PRP are, for now, mostly related to enterprises’ behaviours (e.g. presence of a formal policy concerning health and safety; UNEP-SETAC Methodological sheets for SLCA¹⁸), modifying the physical composition of a product is not a central action in the context of SPC supported by SLCA.

Therefore, hotspots are not identified to support further product design. Learning about and identifying social hotspots can, however, highlight enterprises’ behaviours that should be changed so that they correspond more to the acknowledged social norms carried by SLCA.¹⁹ When the SLCA user cannot change behaviours of enterprises involved in its product system, the other option is to switch to another enterprise, which we believe is the essence of

“substitution in the supply chain”.²⁰ This is not an energy or material input that is changed here but the enterprise supplying this input and therefore the enterprises upstream. Changing enterprises’ behaviours directly fulfills the social goal of SPC (Fig. 2—social goal in bold). However, for a substitution of supply chain actors to induce a change in enterprises’ behaviours, it requires that this substitution create a market incentive for enterprises to do so. Indeed, substituting enterprises with undesired behaviours for enterprises showing better ones in a product system would improve the product’s social profile. However, a market incentive has to be created for the enterprises showing the undesired behaviours to change and, following the implicit assumption behind the use of PRP in SLCA, to improve stakeholders’ social conditions as well as greening²¹ the economy (see Fig. 2).

For substituting supply chain actors in order to improve stakeholders’ social conditions, the buyer (whether a consumer buying consumer goods or a producer buying production inputs) needs adequate information such that his/her purchasing (or absence of) will send the adequate signal to the market. The same principle, but the other way around, has to be followed for marketing, reporting and labeling; responsible enterprises should adequately inform consumers so their purchases comply with desirable social norms that are expected to enhance stakeholders’ social conditions.

Aside from identifying areas of improvement (hotspots) and informing on the behaviours of enterprises potentially influenced by purchasing actions, the intended applications listed by the UNEP-SETAC (2009) includes the establishment of purchasing procedures, of purchasing specifications, strategic planning and the development of public policies. The establishment of purchasing procedures is understood as the attribution of a larger importance to social criteria in the overall purchasing criteria and is believed to be the result of value modifications; this would only be an indirect application of SLCA. Regarding the establishment of purchasing specifications, it is understood as the identification of the adequate criteria to look for (e.g. buying local or fair trade) and would then be similar to the use of SLCA in the identification of labeling criteria (further explain below). Finally, strategic planning and development of

¹⁷ To echo what the SLCA guidelines define as “hotspots”, Quantis, AGECO and CIRAI (2012) suggest the wording “potential hotspots” which are areas in the product system where there is a probability of encountering hotspots. This probability is influenced by the situation in a region, the economic sectors involved, etc. But these hotspots refer to the enterprises or their behaviours one might want to change.

¹⁸ Available on line: http://lcinitiative.unep.fr/default.asp?site=lcinit&page_id=A8992620-AAAD-4B81-9BAC-A72AEA281CB9

¹⁹ This seems to correspond to the intended application of what Jorgensen et al. (2012) define as the “firm lead SLCA”.

²⁰ This seems to correspond to the intended application of the “educative SLCA” in Jorgensen et al. (2012). These authors also argue that changing production level is a mechanism through which the social conditions can be improved by having more stakeholders benefiting from the good behaviours of a growing enterprise. We believe this is true for social impacts related to economic contribution and job creation. However, we consider that the creation of a market incentive is the final expected outcome of buy/boycotting an enterprise on the basis of their behaviours.

²¹ Green is used here as the color of sustainability, and not only environmental sustainability.

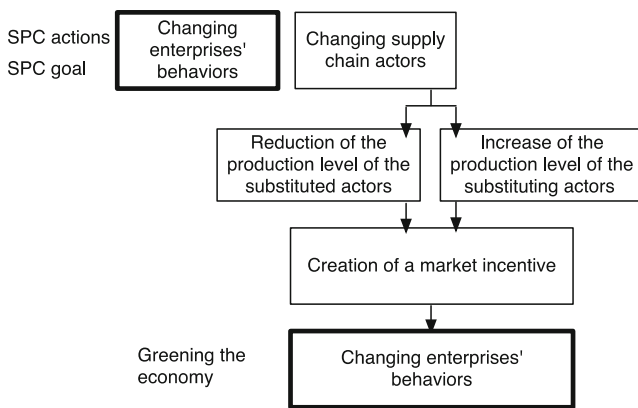


Fig. 2 Theoretical pathways between SCP actions, the SPC social goal and a greener economy

public policies are generic actions that need to involve other actions to achieve the social SPC goal.

In summary, SLCA-PRP can support the SPC' goal of improving enterprises' behaviours in identifying areas of improvement for producers and to guide consumption of products (consumer goods or intermediary products) that will encourage the modification of enterprises' behaviours. The relevance of a LCT in this role is discussed in Section 3.

3 LCT to improve the SPC actions

This third section discusses the relevance of LCT in the context of the different applications identified in the previous section. LCT is understood as the consideration of the different phases that material goods (required to fulfill a function) will cross over during the course of their life, from the extraction of raw materials to the final disposal. The empirical limits of the tools in the different applications are not discussed here (see Jorgensen et al. 2009, for a discussion on limits).

3.1 LCT for the environmental goal of SPC

The ability of LCA to identify hotspots and to compare product systems can support both eco-design and the provision of information to guide consumers. The use of LCA to map impacts on a product system (identifying hotspots) is expected to enhance the life cycle perspective of actors having the ability to physically modify products (the conceptual application described by Heiskanen 1999). This process will make them aware of the impacts occurring in distant phases and helps them identify the sources of these impacts, converging their focus in their search for solutions. A life cycle perspective is relevant since eco-design can modify impacts occurring upstream (e.g. in substituting substances or materials or in reducing their use in a product), at the consumption phase (e.g. in optimizing the energy use) and at the end-of-life (e.g. using

recyclable materials or designing for disassembly). LCA can also be used to validate that an eco-design choice is superior to another; i.e. compare two options to determine the one that most reduces the environmental impacts for a given function. The life cycle perspective is relevant here because environmental impacts can be shifted from one phase of a product life cycle to another as a result of an eco-design choice. For example, knowing that the more impacting phase of an incandescent light bulb is the use phase, an intervention at the product level would be to replace the incandescent light bulb by a compact fluorescent, reducing the energy consumption at the use phase, but this also involves the potential emissions of toxic substances at the end-of-life (CIRAIG 2008).

Also, a life cycle perspective is relevant so as not to omit impacts in the context of informing buyers so they (can) choose the best product among several ones providing the same function. As environmental impacts can be displaced, choosing a product on the basis of an environmental improvement that could create impacts elsewhere in its life cycle would not create the incentive of reducing impacts along the overall life cycle of a product.²² The opposite situation could also be true. An environmental claim prescribing the use of specific materials or substances could also impair the reduction of environmental impacts of products (e.g. this could be the case when not buying compact fluorescent light bulbs on the basis that they include mercury even if—in a specific regional situation—this leads to a reduction of the overall impacts of the light bulb). A life cycle perspective is then required also because, when taking the product angle, an environmental impact somewhere can be justified by a more important environmental gain elsewhere. Therefore, regardless of source of information (marketing campaigns, labels, product declarations, advertisements, etc.), information on impacts along the entire life cycle should be provided to create an incentive for decreasing impacts over the life cycle of products and services. A limit to the relevance of a LCT in guiding consumers (especially households) is that because the consumption and end-of-life phases of a product depend, in part, on consumers' behaviours, it may be hard to give a definitive answer on the impacts of the life cycle of products including the potential displacement of impacts. This said, scenarios of use and end-of-life behaviours could be used in order to not omit the potential impacts occurring during consumption and end-of-life phases when informing consumers.²³

Finally, it is important to note that some actions at the product (A) level would not displace environmental impacts

²² E.g. buying reusable diapers to reduce waste would encourage the production of such diapers. However, if the consumers are in a context where the energy consumed to clean the diapers cancels the reduction of waste, the signal sent to the market will not allow the achievement of the environmental goal of SPC.

²³ CIRAIG-AGECO (2011) uses these types of scenarios in the assessment of different end-of-life management options of computers.

and, consequently, do not require a life cycle perspective. It is the case when an intermediary product (B) is substituted by a similar one (B'), however produced under cleaner production processes (e.g. using inputs that are certified organic²⁴ or FSC). In this case, the intervention modifying the quantity and quality of elementary flow is not at the level of the product A. However, through encouraging the production of a specific intermediary product (B') (e.g. fruits, wood, etc.), a market incentive to produce B' instead of B could be created, modifying elementary flows at this level. The producer of product A does not need to adopt a life cycle perspective in his intervention since there is no physical change in its product system; it does not need to redesign the product. He/she could however use life cycle information to ensure the new option (B') is better than the previous (B). The LCA application here is the provision of information to guide consumers. In summary, LCT is relevant in identifying hotspots and comparing options in the context of eco-design and in the context of providing information to consumers because environmental impacts can be displaced along a product life cycle, and an environmental impact somewhere can be justified by a more important environmental gain elsewhere.

3.2 LCT for the social goal of SPC

As developed above, by assessing enterprises' behaviours, SLCA can support the identification of hotspots in the context of modifying enterprises' behaviours. It also provides information leading consumers to purchase products coming from enterprises behaving in accordance to social norms, with the assumption that it will promote the enhancement of enterprises' behaviours.

Regarding the identification of hotspots in the context of modifying enterprises' behaviours, according to the GRI Boundaries Protocol (GRI 2005), an organization has "the ability to make a change" only within enterprises over which it has influence or control; i.e. over entities it owns totally or in part, enterprises from whom it buys an important share of their sales, enterprises with whom the contractual relationship requires certain operating standards and practices or sustainability performances (see GRI 2005 for a more comprehensive picture of the factors determining influence). Therefore, this action does not require a life cycle perspective, at least not at the phase of identifying the areas of improvement. The adequate perspective to adopt would rather be an "ability to act on" perspective. This may be the reason why this application is not listed in the UNEP-SETAC's guidelines for SLCA (2009). However, if changing enterprises' behaviours could shift impacts anywhere throughout the life cycle, the

validation of a choice (changing enterprises' behaviours inside the sphere of influence) would require a life cycle perspective. Some authors in the SLCA literature have pointed to the risk of transfer of impacts between different types of stakeholders; Kruse et al. (2009) provide an example where "improving working conditions for employees (i.e., one group of stakeholders) could mean increased production costs for the employers (i.e., another stakeholder group), which in turn translates into increased prices for the consumer (i.e., a third group of stakeholders)." In this example, not only does the transfer occur between different stakeholders but also between different life cycle stages. Kruse et al. (2009) pointed to the need for research related to the trade-offs between stakeholders. The same holds true for trade-offs between life cycle stages. Where transfers of environmental impacts occur in the product system through changes in flux of material and energy, it seems it could occur for the social dimension as well through changes in the allocation of monetary flux along the life cycle. Therefore, for SLCA, used in the identification of behaviours to change inside the sphere of influence, to deserve the "LCT label", it has to capture those trade-offs.

To act outside the sphere of influence, a producer can substitute the supply chain actors providing an intermediary product. This is a second action potentially supported by SLCA. For a producer to substitute supply chain actors on the basis of their social performances, he/she needs appropriate information on the supply chain he/she will sever, as well as on the substituting supply chain. Indeed, substituting supply chain actors that actually do not have wrong behaviours for ones that do would not send the appropriate message to the market. The same holds true for consumers choosing products on the basis of the social performances of the actors involved in a product system. Therefore, being aware of the behaviours of every actor involved in the value chain would allow consumers (industrial or household) to encourage (or not) enterprises on the basis of known practices. Providing information on supply chains and product systems requires a cradle-to-retailer²⁵ to ensure that no unwanted behaviour is encouraged. For a life cycle perspective to be relevant, effects induced elsewhere in the life cycle (e.g. a producer substituting a supply chain for another one leading to an increase of the price of its product and therefore affecting consumers) would have to be captured by the SLCA. Without the consideration of the potential shifting of impacts into consumption and end-of-life phases, it does not seem relevant to provide information about downstream enterprises' behaviours to support substitution of supply chain. An exception to this would be if the enterprises providing products' end-of-life services would become "suppliers", i.e. that the SLCA user could influence or substitute them (e.g. under an extended producer

²⁴ Organic farming is not always better for every impact category [e.g. Thomassen et al. (2008a, b) found higher global warming potential in organic dairy farms than in conventional].

²⁵ Acknowledging that the retailer can be the producer if he/she sells without intermediary.

responsibility scheme). So, a cradle-to-retailer perspective seems relevant so as not to omit unwanted behaviours when purchasing a product or an intermediary product.

It is important to point here that the cradle-to-retailer perspective holds economic actors liable for the behaviours of their suppliers and even clients. To illustrate this idea, let us use the example of a fictive subsystem (supply chain) composed of three enterprises. The first enterprise directly supplies the SLCA user (e.g. a producer willing to improve its product social performance) and is within its sphere of influence. The second enterprise supplies this first supplier and is within its sphere of influence, but not in the SLCA user's one. Finally, the third enterprise supplies the second supplier and is outside the sphere of influence of all other actors (Fig. 3).

If the enterprise showing unsustainable practices is the first supplier, it is expected that the organization will try to influence its behaviour before substituting this supplier. If it does not succeed to induce a change, the organization may end up changing its supplier (and the ones upstream). In this case, the second supplier might want to ensure its client shows good behaviour so as not to lose a market share. If the enterprise showing unsustainable practices is the second supplier, the organization may try to convince its first supplier to influence the second one and, if it does not succeed, replace its first tier supplier to get rid of the second one. In this case, the first supplier might want to ensure that its supplier behaves in accordance with the SLCA norms. If the enterprise showing unsustainable practices is the third supplier, the organization may try to convince its first supplier to convince its supplier (the second one) to substitute its own supplier (the third one). So not only should the second supplier influence its own suppliers to behave appropriately but it should also sever contracts with suppliers he/she cannot influence. In the case that the second supplier would choose not to sever its supplier showing hotspots, then all three suppliers would be severed. LCT reinforces the liability for social performance outside the enterprise's walls (as suggested by the GRI), but also outside the sphere of influence (cf. the ripple effect concept, Robinson and Strandberg 2007). For enterprises to become concerned and act so their business partners show good behaviours as well, showing good behaviour throughout a supply chain has to become a competitive advantage, which could be the result of the use of SLCA to guide consumers' purchases.

In summary, SLCA has to capture potential shifts of impacts (or more precisely, shift of behaviours affecting stakeholders' social conditions along the life cycle) for life cycle perspective to find its *raison d'être* in SLCA. Without it, the system boundaries for a tool identifying hotspots should rather be based on the sphere of influence when influencing changes in behaviours or on a cradle-to-retailer perspective when guiding substitution.

4 Consideration in the use of SLCA in SPC

In this last section, we wish to point to some considerations we believe should be taken into account when developing SLCA in the context of SPC. We raise questions, but other articles will have to answer them.

SPC is acknowledged as a means to green the economy; at least, this is the case for the environmental dimension of a green economy (UNEP 2011b). For SPC to socially green the economy, it requires that purchasing (or not) from enterprises on the basis of their behaviours creates a market incentive leading to a change in enterprises' behaviours all over the economy.²⁶ For a buy/boycott to create a market incentive for the enterprise, we argue that the criteria on which purchases are based have to be those on which enterprises can act. To take a counterexample, Finkbeiner et al. (2010) suggest gathering information on the Human Development Index (HDI), the Gini coefficient and the commitment to comply with the criteria of the UN Global Compact as indicators in SLCA. Although enterprises can commit to the UN Global Compact, they have individually little influence on both HDI and Gini coefficient which are result indicators at the macro level. And even if they do (e.g. large company), the pathway between the boycott of an enterprise on the basis of the state of social indicators at the country level and the creation of an incentive for enterprises to change their practices deserves a closer look. In other words, would boycotting an enterprise on the basis of a situation in the host country lead to changes in practices of this enterprise, other enterprises in this country or enterprises anywhere in the global economy? This has to be considered when using the Social hotspots database,²⁷ a database developed for SLCA and providing information at the country level (and sometime sector level) following the guidelines' (UNEP-SETAC 2009) definition of hotspots.

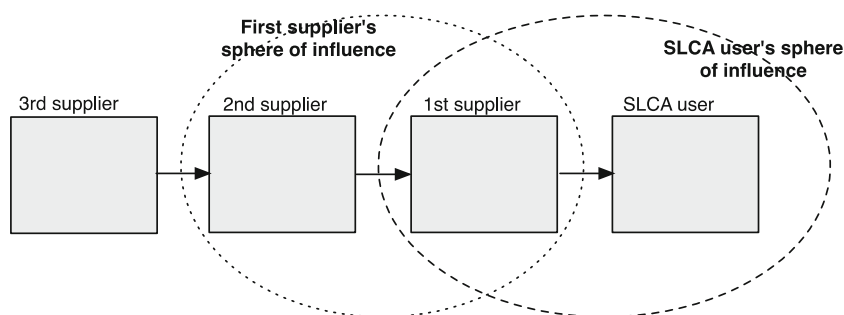
For SPC to socially green the economy, it also requires that boycotting and severing supply chains are an acceptable means for creating a market incentive acknowledging that it can lead to negative impacts.²⁸ To use market forces to change P&C patterns so their environmental impacts are

²⁶ And as mentioned in footnote #16, compliance to some social norms will have to lead to better social conditions, which is not always straightforward, as suggested in the child labour example of Clift et al. (2012).

²⁷ socialhotspot.org

²⁸ Jorgensen et al. (2012) give the example of Nike severing a supplier that employs children in their workforce, leading to worse social conditions for the workers and the local society. We argue, however, that as the enterprise (Nike) has to have a very important economic influence on the supplier to create that negative impact, it probably had the "ability to make a change" (GRI 2005). Therefore, severing the supplier would be (in the state-of-the-art) a last resort, after negotiations to change behaviours have taken place (Quairel and Auberger 2007).

Fig. 3 Example of a supply chain with different relations of influence between the economic actors



reduced is advocated, for example, by the European Integrated Product Policy (CEC 2001, 2003). But this means has poorly been reflected on in the context of the social dimension of SPC. This reflection, if even more important in the hope of using LCA and SLCA together, acknowledges that a decrease in the production level of polluting production processes is the desired environmental goal of SPC (as schematized in Fig. 1), while it is an unwanted but obligated step for the achievement of the social goal (as shown in Fig. 2). It raises the question of whether the negative impacts caused by the boycotting and severing of supply chains will actually lead to a change in practices in the economy and if the social gain of this potential change justifies punctual negative social impacts? The same question can be asked for an environmental gain; can it justify punctual social negative impacts?

The acceptability of the creation of a social impact for a greater social gain also suggests reflecting on the role of the functional unit (FU) in SLCA. Whether the negative impacts are created from the boycotting or severing of supply chains²⁹ or whether it results of a transfer of impacts in the life cycle (see Section 3), would an impact created at one process of the economy or the product system be justified by a reduction of the impacts of the FU? In the context of reducing the environmental impact in the economy, LCA ensures the services (or functions) consumed in an economy are eco-efficient, that their impacts are as small as possible. Reducing the impacts of a FU might require raising the impact of one unit process (e.g. mercury at the end-of-life of a light bulb) to lower the ones of another process (e.g. energy consumption) if it results in an overall reduction of impacts (e.g. a light bulb with lower impacts than the alternative). Among other uses, the FU is the level at which the reduction of impacts is targeted. The question of whether the FU is an appropriate target for the enhancement of social conditions directly affects the way SLCA results have to be interpreted and, therefore, presented (e.g. should the results be aggregated and reported on the FU or not?). Trade-offs between the different dimensions of sustainable development are already in the Life Cycle Sustainability

Assessment research agenda (UNEP-SETAC 2009; UNEP 2011a). We stress that trade-offs between different areas in a product system³⁰ as well as questions on the acceptability of a certain amount of negative impacts for a better performance at the FU level have to be put on the agenda.

Another consideration is related to site-specific versus generic data. The difficulty of collecting site-specific data has already been discussed in Jorgensen et al. (2009, 2012). What we wish to point here is that site-specific data might be necessary to inform consumers and enterprises on supply chain actors' behaviours so that substitutions are made on the basis of their actual behaviours and not on the probability of encountering unwanted behaviours, as stated by Jorgensen et al. (2012). However, generic data might be enough to support the selection of criteria (life cycle steps and social aspects to look for) in the elaboration of a labeling program as described by ISO 14024 (1999). For example, Blom and Solmar (2009) performed a SLCA on bioethanol using generic data and found that the life cycle step of the biomass production is of major concern since forced labour can be encountered. This suggests that this life cycle step (biomass production) and this social concern (forced labour) would be unavoidable criteria to address in a label or certification scheme on that product.

Finally, a last consideration concerns the cut-off criteria or the system boundaries. An intervention at the product level that would be guided by LCA alone could result in a change of a subsystem regardless of the liability of the actors involved in that subsystem with regard to the environmental impacts one strives to avoid. As an example, an eco-designer could substitute an input produced in a country with a grid mix dominated by fossil energy for the same input produced in a country with a grid mix dominated by hydro-electricity. Considering that the producers involved in the supply of this input have probably little influence on the electricity production of the country, this action would severe economic actors for choices made at the policy-making level on which they have little influence.

Taking the same action for social motives, one could boycott a whole supply chain for behaviours of an actor that

²⁹ Which could theoretically be measured by consequential SLCA (Jorgensen et al. 2012).

³⁰ Or the economy, if one is taking a consequential approach.

can neither be influenced nor substituted by the other actors of the supply chain (e.g. in the case of a monopoly). The extended liability of supply chain actors over their business partners reinforced by the LCT (or cradle-to-retailer perspective) is powerless in this case. This raises the question of whether a market incentive is a good pathway to induce a change in these actors' behaviours. And if not, whether they should be included in the system so their behaviours influence decisions about purchases.

In conclusion, this article pointed to the importance of framing the use of Life Cycle Sustainability Assessment tools in their context of use. In the case of SPC, we have highlighted different roles and pointed to areas of research that are not yet in the LCSA research agenda, such as the effects of a change of behaviour at one phase can have on behaviours at other phases. But for LCSA tools to support the achievement of environmental and social SPC goals, their combined use will have to be thought not only through the guidance of purchasing decisions (where this SPC action can be supported by LCA U SLCA) but also within the frame of other SPC actions. The SLCA applications discussed here were those having direct effects on production and consumption patterns. Education would be another application that has less direct effects but, as the consideration of the social dimension into SPC is fairly new, might be a very valuable one. However, as a decision support tool, SLCA will have to be developed not only to make LCA sustainable but also to move production, consumption and the economy towards sustainability.

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